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Risk factors associated with self-reported training-related injury before arrival at the US army ordnance school

T.L. Grier*, J.J. Knapik, S. Canada, M. Canham-Chervak, B.H. Jones

US Army Center for Health Promotion and Preventive Medicine, Directorate of Epidemiology and Disease Surveillance, 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010, USA

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SUMMARY

Objective: This study examined risk factors for self-reported injury incurred before arrival at Ordnance School for advanced individual training (AIT).
Study design: During AIT in-processing, soldiers ($n = 27{,}289$ men and 3856 women) completed a questionnaire that collected demographic and lifestyle information, and asked if the soldier currently had an injury that would affect their AIT performance.
Methods: Potential risk factors for self-reported injury were explored using logistic regression.
Results: For men, self-reported injury was associated with older age [odds ratio (OR) ≥30years/17–19 years = 1.9], race (OR Black/Caucasian = 1.2), basic combat training (BCT) site (OR Fort Benning/Fort Jackson = 1.7; OR Fort Leonard Wood/Fort Jackson = 1.6, OR Fort Knox/Fort Jackson = 1.3), smoking on 20 or more days in the 30 days prior to BCT (OR smoker/non-smoker = 1.2) and current illness (OR ill/not ill = 6.2). For women, increased self-reported injury was associated with older age (OR ≥ 30years/17–19 years = 2.0), BCT site (OR Fort Leonard Wood/Fort Jackson = 1.5) and current illness (OR ill/not ill = 5.8).
Conclusions: Certain demographic characteristics and lifestyle behaviours may be identified as injury risk factors on arrival at Ordnance AIT.
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Introduction

During basic combat training (BCT), recruits train to become skilled at military tasks which include activities such as rifle marksmanship, bayonet use, negotiating obstacle courses, hand-to-hand combat, first aid, drill and ceremony, and other activities. Physical fitness training is conducted four to six times per week and consists of both aerobic and strength training exercises. Recruit fitness, prior physical activity level, age and lifestyle characteristics will vary markedly from recruit to recruit on entry to BCT.[1,2] Many of these factors have been shown to influence the incidence of injury,[2–4] which has been reported to range between 21% and 42% for men and between 41% and 67% for women during BCT.[5] Three known risk factors for injuries in BCT include age, gender and smoking cigarettes.[5] It has been reported (anecdotally) that trainees often leave BCT injured and enter advanced individual training (AIT) with pre-existing injuries. In 2004, Department of Defense service members experienced almost 25 million days of limited duty due to injuries.[6]

* *Corresponding author*. Tel.: +1 410 436 5450; fax: +1 410 436 5449.
E-mail address: Tyson.Grier@us.army.mil (T.L. Grier).
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In AIT, soldiers learn their military occupational specialty (MOS). AIT can last from 4 weeks to over 1 year, depending on the MOS. Two studies have previously examined injury risk factors during AIT. One study[7] was carried out during the 10-week combat medic course and found that the incidence of injury was 24% for men and 30% for women. The largest proportions of injuries were overuse and lower body injuries. Injury risk factors for women included split option (when a high school student attends BCT and then returns to finish their last year of school before entering active duty), higher body mass and older age (>25 years). For men, none of the examined injury risk factors were significant. The second investigation[8] examined injury risk factors among male soldiers attending Ordnance AIT. They found that increased injury risk was associated with lower military rank, self-reported prior injury, prior cigarette smoking and low performance on the initial physical fitness test (push-ups, sit-ups and 2 mile run).

This report examines possible risk factors associated with self-reported training-related injuries on arrival at Ordnance AIT. Identification of these risk factors may assist in the detection of soldiers entering AIT with pre-existing injuries, and could be used in policy development.

Methods

Participants

Participants were service members attending AIT in the 16th and 143rd Ordnance battalions at Aberdeen Proving Ground (APG) from January 2000 to December 2006. Most students were Army personnel, with less than 1% from the Navy, Marines and Air Force. Army students had graduated from their respective services' basic training course within 4–6 days prior to in-processing at APG, or were currently serving in the military and had been reclassified. However, the majority of students in AIT are recent BCT graduates.

Data collected

Arriving AIT students were in-processed into the Ordnance School once a week. In-processing groups averaged 99 students [standard deviation (SD) 24], ranging in group size from 4 to 221. As a part of the in-processing procedure, each student was asked to complete a soldier health in-processing (SHIP) questionnaire. Each question was read by a moderator and then completed by the service member after the reading of the question. The SHIP survey contains questions on date of birth, gender, military rank, race, BCT site, whether or not they currently had an injury or illness (occurring before, during or after BCT) that would affect their AIT performance, and history of tobacco use. Military rank generally consisted of the ranks E1–E5. Private or E1–E2 are the lowest ranks, and the soldier's primary role is to carry out orders issued to them. Private First Class or E3's are promoted after 1 year or earlier if requested by a supervisor, and carry out orders to the best of their ability. A specialist (E4) can manage enlisted soldiers and has attended specific training to earn their promotion, or was able to enter BCT as an E4 because they had a 4-year degree. A corporal (E4) serves as a team leader of the smallest Army units. A sergeant (E5) typically commands a squad of 9–10 enlisted soldiers.

The tobacco use questions asked if the service member had smoked one or more cigarettes within the 30 days prior to BCT, and if they had smoked on 20 of the 30 days prior to BCT. If soldiers answered 'yes' to smoking one or more cigarettes within the last 30 days prior to BCT, but 'no' to the question asking if they had smoked on 20 or more days in the 30 days prior to BCT, they were considered an 'occasional smoker.' If they answered 'yes' to smoking on 20 of the 30 days prior to BCT, they were considered a 'frequent smoker'. If the soldiers answered 'yes' to smoking cigarettes, they were also asked how many cigarettes they smoke per day (<10, 10–20 or >20). Those who answered 'yes' to using smokeless tobacco at least once in the 30 days prior to BCT, but 'no' to the question asking if they had used smokeless tobacco on 20 or more days in the 30 days prior to BCT were considered 'occasional smokeless tobacco users', and those who reported using smokeless tobacco on 20 or more days in the 30 days prior to BCT were considered 'frequent smokeless tobacco users.' If the soldiers answered 'yes' to using smokeless tobacco, they were also asked how many pouches, plugs or cans they used per day on average (<1, 1 or $\geq$2).

Data analysis

Statistical Package for the Social Sciences Version 15.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Age was calculated from date of birth to the date when the service member was in-processed at the Ordnance School. Descriptive statistics were calculated for demographics (age, gender, race, military rank), BCT site, injury, illness and tobacco use variables. Potential risk factors for self-reported injury were explored using logistic regression. Odds ratios (OR) and 95% confidence intervals (95%CI) were calculated for each risk factor (independent variables). Variables from the univariate analysis with a statistical significance of $P < 0.05$ were selected for a backward stepping multivariate logistic regression. A statistical significance less than 0.05 was required for retention in the model. Multivariate OR and 95% CI were calculated.

Results

Descriptive statistics

In total, 27,289 men and 3856 women completed the questionnaire between 2000 and 2006. The majority of the recruits entering AIT were men, between the ages of 17–24-years [mean (SD) 20 (2) years], Caucasian, lower military rank (E1) and had attended basic training at Fort (Ft) Knox or Ft Jackson. When service members were asked if they presently had an injury that would interfere with their training, 17% of the women and 8% of the men responded positively (risk ratio women/men = 2.3, 95%CI 2.1–2.5). The majority of these injuries were reported to have occurred during BCT (80% for men and 91% for women).

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Risk factors for self-reported injury

Table 1 displays the results of the univariate logistic regression analysis with self-reported injury as the dependent variable. For men, injury risk was higher with older age, Black race (relative to Caucasians), military rank of E1 (relative to E3), a BCT location other than Ft Jackson, a current self-reported illness and being a frequent smoker. For women, injury risk was higher among those who were older, were of 'other' races (relative to Caucasians), were E4s (compared with E1s), had basic training at Ft Leonard Wood (compared with Ft Jackson) and/or had a current self-reported illness. Use of two or more cans, pouches or plugs of smokeless tobacco was not included in the model for women due to the limited number of responses ($n = 2$).

Table 2 shows the results of a backward stepping multivariate logistic regression analysis with self-reported injury as the dependent variable. There were 24,177 (89%) men and 3527 (92%) women who had complete data on all the variables and who could be included in the multivariate analysis. Cigarettes smoked per day and tobacco use were highly correlated, so only the tobacco use question was chosen for entry into the multivariate model. For men, self-reported injury was independently associated with older age, Black race (relative to Caucasians), attending BCT training at Ft Benning, Ft Leonard Wood or Ft Knox (compared with Ft Jackson), having a current self-reported illness and smoking. For women, self-reported injury was independently associated with older age, attending training at Ft Leonard Wood (compared with Ft Jackson) and having a current self-reported illness.

Discussion

This study identified injury risk factors for self-reported injury on arrival at Ordnance AIT. Risk factors for men included older age, Black race (relative to Caucasians), BCT site, current self-reported illness and cigarette use. For women, higher injury risk was associated with older age, BCT site and having a current self-reported illness.

Age was independently associated with a self-reported injury and a dose–response was found (as age increased, self-reported injury also increased). Other investigations during BCT and AIT have also shown that older recruits are at higher risk of being injured.[2,4,7,9] It has been suggested that when younger and older recruits train at similar frequencies, intensities and durations (as in BCT), the older recruits are at a greater risk of injury, possibly because of age-related fitness factors.[4] With aging, there is a decrease in run speed and muscular endurance, in addition to a decrease in lung vital capacity and aerobic capacity. These declines may contribute to the higher likelihood of injury.[10,11] The civilian literature is inconsistent when investigating the association between age and injury, with some studies of physically active individuals showing no association,[12–14] and other studies showing that older age is associated with injury.[15–18] However, few if any civilian studies achieve the level of standardization in terms of exercise, occupational activity and living conditions that are found in a military student environment.

Black men and women of 'other' races had higher injury risk. Studies show that Black men were 2.9–4.2 times more likely to experience a lower extremity tendon injury compared with Caucasians,[19,20] possibly because of greater muscle viscosity and muscle stiffness.[21] On the other hand, it has been shown that Blacks are less likely to develop stress fractures compared with Caucasians,[22] possibly because Blacks have a higher bone density than Caucasians.[23,24] Other studies performed during BCT and AIT have shown no differences in injury risk by race. [4,7,25]

For men, those arriving from Ft Knox, Ft Leonard Wood and Ft Benning had significantly higher injury rates than those arriving from Ft Jackson. For women, those arriving from Ft Leonard Wood had a significantly higher injury rate than those arriving from Ft Jackson. Recruits arriving from Ft Jackson could have lower injury risk due to the multiple injury reduction interventions introduced at Ft Jackson.[5] In 1998, the Ft Jackson Training Center commander increased emphasis on reducing injury rates and established an injury co-ordinator position to provide advice and material support for commanders and drill sergeants in reducing injury rates. Programme monitoring through surveys and surveillance suggests that these interventions were associated with a reduction in injury rates. Further, there have been several other epidemiological consultations resulting in suggestions for injury reduction measures at Ft Jackson, and these have been well documented.[2,3,25–30] Alternately or concurrently, differences in environmental factors (e.g. terrain, distance from barracks to training sites, weather) may explain these differences.

Thirty-one percent of men and 50.5% of women who reported being injured also reported being ill, and current illness was one of the strongest risk factors for injury. Other investigations of injuries and illnesses in military populations[31–34] show that high injury rates are also associated with higher illness rates. It is possible that the multiple stressors of BCT could result in both injuries and illnesses.

For men, self-reported injury was higher among frequent smokers. Previous studies have also demonstrated this relationship.[2,9,35,36] More specifically, several studies have found that smokers are at increased risk of musculoskeletal injury,[35,37–39] impaired healing of fractures and wounds,[40–42] and low bone density.[43–46] The increase in musculoskeletal injury may be due to a compromised ability to repair damaged tissues, thereby increasing susceptibility to overuse injuries.[47] Impaired healing of fractures and wounds could be attributed to decreased oxygen saturation levels and/or impaired blood flow to the injured area. Low bone density could be effected by nicotine which appears to interfere with bone metabolism through decreased osteoblastic function[48] and calcitonin resistance as a result of smoking.[49] Other studies have found that injury risk increases with the amount of cigarettes smoked per day.[2,35,36]

One of the limitations of this project could have been the question for self-reported injuries asking 'Do you have an injury that would adversely affect your performance during AIT?' In answering this question, the soldier's perception of injury limitations could have been influenced by their anticipation associated with their MOS, which can vary in terms of

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Table 1 – Univariate Logistic Regression Results by Gender with Self-Reported Current Injury as the Dependent Variable

Variable	Survey Question	Category of Variable	Men				Women			
			N	Reported Injury (%)	Odds Ratio (95%CI)	P-Value	N	Reported Injury (%)	Odds Ratio (95%CI)	P-Value
Age Group		17-19	12913	6.4	1.00	–	2078	15.6	1.00	–
		20-24	9893	8.2	1.29 (1.17-1.43)	<0.01	1168	19.3	1.29 (1.07-1.56)	<0.01
		25-29	2485	10.2	1.65 (1.43-1.92)	<0.01	342	19.3	1.29 (0.96-1.74)	0.08
		≥ 30	1368	11.4	1.87 (1.56-2.24)	<0.01	180	27.2	2.02 (1.43-2.87)	<0.01
Race		Caucasian	16591	7.5	1.00	–	2022	16.6	1.00	–
		Black	4070	9.1	1.23 (1.08-1.38)	<0.01	788	18.4	1.13 (0.91-1.40)	0.26
		Asian	818	6.5	0.85 (0.64-1.13)	0.27	114	15.8	0.94 (0.56-1.58)	0.82
		Hispanic	3666	6.9	0.91 (0.80-1.05)	0.21	541	18.9	1.17 (0.91-1.49)	0.22
		Native	720	8.3	1.12 (0.85-1.46)	0.42	160	20.6	1.30 (0.87-1.95)	0.19
		Other	780	8.1	1.08 (0.83-1.41)	0.57	144	22.9	1.49 (0.99-2.24)	0.05
Rank		E1	14014	8.0	1.00	–	1828	16.6	1.00	–
		E2	6386	7.5	0.94 (0.84-1.05)	0.29	967	18.1	1.11 (0.91-1.36)	0.31
		E3	4965	7.1	0.88 (0.78-1.00)	0.04	851	17.7	1.09 (0.88-1.35)	0.45
		E4	967	8.1	1.01 (0.80-1.29)	0.91	100	27.0	1.86 (1.18-2.94)	<0.01
		≥E5	341	6.7	0.84 (0.54-1.28)	0.41	22	9.1	.50 (0.12-2.17)	0.50
Basic Training Site		Ft Jackson	8513	6.6	1.00	–	3136	16.9	1.00	–
		Ft Knox	13560	8.1	1.25 (1.12-1.39)	<0.01	27	18.5	1.12 (0.42-2.97)	0.82
		Ft Leonard Wood	1042	9.1	1.42 (1.13-1.78)	<0.01	463	22.7	1.44 (1.14-1.83)	<0.01
		Ft Benning	1646	9.7	1.51 (1.26-1.82)	<0.01	[a]	[a]	[a]	[a]
		Ft Sill	1380	7.6	1.16 (0.94-1.45)	0.17	115	18.3	1.10 (0.68-1.78)	0.70
		Other	430	6.3	0.95 (0.64-1.41)	0.79	26	19.2	1.17 (0.44-3.13)	0.75
Illness	Do you presently have an illness?	No	25596	6.5	1.00	–	3556	15.3	1.00	–
		Yes	477	31.0	6.50 (5.32-7.94)	<0.01	103	50.5	5.66 (3.8-8.4)	<0.01
	If yes, when did your illness begin?	Prior to BCT	61	34.4	1.00	–	17	47.1	1.00	–
		During BCT	196	33.2	0.94 (0.52-1.73)	0.85	61	50.8	1.16 (0.40-3.41)	0.78
		After BCT	53	30.2	0.82 (0.37-1.81)	0.63	9	55.6	1.41 (.28-7.13)	0.68
Tobacco (Cigarettes)		Non-smokers	14765	7.3	1.00	–	2240	17.8	1.00	–
		Occasional	2098	8.3	1.15 (0.97-1.36)	0.10	295	18.0	1.01 (0.74-1.39)	0.95
		Frequent	9622	8.3	1.16 (1.05-1.27)	<0.01	1239	17.2	0.96 (0.80-1.15)	0.65
	Number of cigarettes smoked/day	Non-smokers	14765	7.3	1.00	–	2240	17.8	1.00	–
		10 or less	2876	8.7	1.22 (1.05-1.40)	<0.01	479	18.4	1.04 (0.80-1.34)	0.77
		10-20	4264	7.7	1.07 (0.94-1.21)	0.32	521	16.5	0.91 (0.71-1.18)	0.48
		20 or more	2309	8.9	1.25 (1.07-1.46)	<0.01	216	16.2	0.89 (0.61-1.30)	0.55
Tobacco (Smokeless)		Non-smokeless	21959	7.7	1.00	–	3614	17.7	1.00	–
		Occasional	1327	7.6	0.99 (0.80-1.22)	0.91	52	11.5	0.61 (0.26-1.43)	0.26
		Frequent	2929	8.3	1.08 (0.94-1.24)	0.29	65	23.1	1.40 (0.78-2.51)	0.26
	Number of cans, pouches or plugs?	Non-smokeless users	21959	7.7	1.00	–	3614	17.7	1.00	–
		Less than 1 can	1770	8.2	1.07 (0.90-1.28)	0.46	43	23.3	1.41 (0.69-2.88)	0.34
		1 can on average	895	8.0	1.05 (0.82-1.34)	0.71	8	12.5	0.67 (0.08-5.43)	0.70
		2 or more cans	146	7.5	0.98 (0.53-1.81)	0.94	[b]	[b]	[b]	[b]

Table 2 – Multivariate logistic regression by gender with self-reported injury as the dependent factor.

Variable	Survey question	Category	Men			Women		
			n	Odds ratio (95%CI)	P-value	n	Odds ratio (95%CI)	P-value
Age group (years)		17–19	12,042	1.00	–	1960	1.00	–
		20–24	9096	1.24 (1.11–1.39)	<0.01	1085	1.30 (1.06–1.60)	0.01
		25–29	2287	1.70 (1.44–2.00)	<0.01	319	1.47 (1.08–2.00)	0.02
		≥30	1230	1.89 (1.54–2.33)	<0.01	163	1.99 (1.35–2.91)	<0.01
Race		Caucasian	15,514	1.00	–	b		
		Black	3629	1.22 (1.06–1.40)	<0.01			
		Asian	742	0.83 (0.60–1.14)	0.24			
		Hispanic	3394	0.90 (0.77–1.05)	0.17			
		Native	676	1.22 (0.92–1.62)	0.17			
		Other	700	1.10 (0.82–1.47)	0.55			
BCT site		Ft Jackson	8011	1.00	–	2943	1.00	–
		Ft Knox	12,549	1.30 (1.15–1.46)	<0.01	22	0.96 (0.28–3.25)	0.94
		Ft Leonard Wood	955	1.56 (1.21–1.99)	<0.01	436	1.49 (1.16–1.92)	<0.01
		Ft Benning	1481	1.67 (1.36–2.04)	<0.01	a	a	a
		Ft Sill	1255	1.13 (0.88–1.45)	0.33	102	0.87 (0.50–1.53)	0.63
		Other	404	0.85 (0.55–1.30)	0.45	24	0.93 (0.31–2.81)	0.90
Illness	Do you presently have an illness?	No	24,208	1.00	–	3425	1.00	–
		Yes	447	6.18 (5.00–7.62)	<0.01	102	5.80 (3.87–8.67)	<0.01
Tobacco (cigarettes)		Non-smokers	13,740	1.00	–	c		
		Occasional	1949	1.20 (0.99–1.44)	0.06			
		Frequent	8966	1.20 (1.08–1.34)	<0.01			

BCT, basic combat training; CI, confidence interval.
a Women did not attend BCT at Ft Benning.
b Did not reach the final step in the backwards stepping multivariate logistic regression.
c Not retained in the model because it did not meet the $P < 0.05$ criteria in the univariate analysis.

physical demands and duration of training. Therefore, if they had an injury, it may or may not have affected their performance, but they could only answer this question as to how they perceived the level of difficulty associated with their MOS. This could also be applicable to the question ‘Do you have an illness that would adversely affect your performance during AIT?’

This report identified possible risk factors associated with self-reported training-related injuries on arrival at Ordnance AIT. The present study suggests that older age, self-reported illness, Black race and cigarette smoking (for men only) may represent a high-risk population for being injured during AIT. For BCT sites, unique information was found indicating a lower injury risk among service members arriving from Ft Jackson compared with Ft Knox and Ft Benning for men and Ft Leonard Wood for both men and women. It is possible that injury reduction strategies employed at Ft Jackson could account for this lower risk.

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The views, opinions and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy or decision, unless so designated by other official documentation. Approved for public release; distribution is unlimited.

Ethical approval

This project used a previously anonymised database and the project was determined to be Public Health Practice.[50]

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Competing interests

None declared.

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